PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-192712
(43)Date of publication of application : 21.07.1999

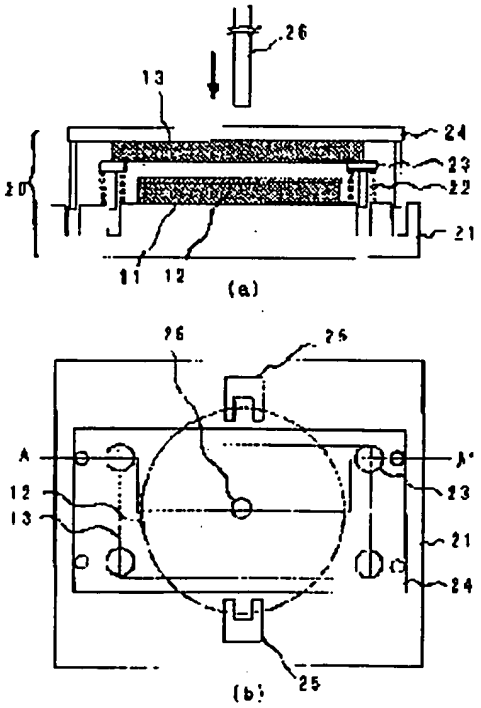
(51)Int.Cl. B41J 2/16
C03C 27/02

(21)Application number : 10-000035
(22)Date of filing : 05.01.1998

(71)Applicant : SEIKO EPSON CORP
(72)Inventor : MAEDA YOSHIO
KOMATSU HIROSHI
SHIMIZU NOBUO
MOMOSE YOSHIMASA
YAGI HIROSHI
TANAKA SHUSUKE

(54) METHOD AND APPARATUS FOR ANODIC BONDING OF SUBSTRATE

(57)Abstract:
PROBLEM TO BE SOLVED: To realize an anodic bonding method holding the middle substrate between upper and lower substrates to a strain free state when three substrates are to be anodically bonded.
SOLUTION: A bonding apparatus 20 is equipped with a first applying electrode plate 21, the supporting and holding part 23 urged upwardly by a coil spring 22, a second applying electrode 24 and a third applying electrode plate. A lower substrate 11 and a middle substrate 12 are held to a close contact state and the first anodic bonding of these substrates is performed and, thereafter, an upper substrate 13 is pressed to the middle substrate 12 in a close contact state in the same heating state raised in temp. at the time of the first anodic bonding to perform second anodic bonding.



LEGAL STATUS

[Date of request for examination] 31.08.2004

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] Three substrates of the 1st, 2nd, and 3rd substrates are set to superposition and the approach of joining. Hold, where the 1st and 2nd substrates are stuck, and the 3rd substrate is held in the state of non-contact to the upper part. The anode plate junction approach of the substrate which performs 1st anode plate junction between said 1st and 2nd substrates after a heating temperature up for said the 1st thru/or 3rd substrate, is made to carry out the press descent of said 3rd substrate on said 2nd set plate surface after that, and is characterized by performing 2nd anode plate junction between said 3rd substrate and said 2nd substrate.
[Claim 2] It is the anode plate junction approach of the substrate characterized by for said 1st and 3rd substrates being glass substrates in claim 1, and the 2nd substrate being a semi-conductor substrate.
[Claim 3] It is the anode plate junction approach of the substrate characterized by being the semi-conductor substrate equipped with the thin-walled part from which said 2nd substrate serves as diaphram locally in claim 2.

[Claim 4] It is the anode plate junction approach of the substrate characterized by being joined after said 1st, 2nd, and 3rd substrates have a front face defecated through RCA washing in claim 2.
[Claim 5] Three substrates of the 1st, 2nd, and 3rd substrates are set to superposition and the junction equipment which carries out anode plate junction. The 1st impression electrode which is laid where the 1st and 2nd substrates are stuck and which both touches said 1st substrate, In the condition that the inferior surface of tongue of the 3rd substrate countered above said 2nd substrate in the state of the top face of said 2nd substrate, and non-contact, and the two condition in the condition that the inferior surface of tongue of the 3rd substrate contacted the top face of said 2nd substrate The 2nd impression electrode which touches the top face of the supporter which supports said 3rd substrate, and said 3rd substrate supported by said supporter, The 3rd impression electrode which touches said 2nd substrate, and after said supporter has supported said 3rd substrate in the state of said 2nd substrate and non-contact, an electrical potential difference is impressed to said 1st and 3rd impression inter-electrode. Anode plate junction equipment of the substrate characterized by having an electrical-potential-difference impression means to impress an electrical potential difference to said 2nd and 3rd impression inter-electrode where said 3rd substrate is supported in the state of said 2nd substrate and contact.
[Claim 6] Anode plate junction equipment of the substrate characterized by having pressed caudad said 3rd substrate supported by said supporter by the bigger force than the energization force of an energization means to energize said supporter up, and this energization means, having moved this substrate caudad with the supporter, and having said 2nd substrate and the press means to stick in anode plate junction equipment according to claim 5.
[Claim 7] Said 2nd substrate supported by said 1st impression electrode in the condition of having been stuck with said 1st substrate, in anode plate junction equipment according to claim 5 It is anode plate junction equipment of the substrate characterized by having at least one metal metallic ornaments which carry out press immobilization more nearly locally than the upper part, and arranging these metal metallic ornaments in the condition of having insulated with the 1st impression electrode plate, and functioning as 3rd impression electrode.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the junction approach of a substrate, and junction equipment, is faced performing anode plate junction of a three-layer substrate especially, and relates to the equipment or the fixture the suitable anode plate junction approach and for joining.
[0002]
[Description of the Prior Art] The various techniques for joining semi-conductor substrates, a semi-conductor substrate, and a glass substrate conventionally are known. For example, in the micro-machining field, a silicon wafer (henceforth a semi-conductor substrate) and a borosilicate glass substrate (only henceforth a glass substrate) are contacted, there is a technique which joins a semi-conductor substrate and a glass substrate by anode plate junction in this condition, and the attempt which manufactures various micro components, such as a pressure sensor and an ink jet head, with this technique is made.
[0003] Drawing 7 shows the manufacturing installation of an ink jet head which used such an anode plate junction technique. Much surface crevice 11a is formed in the front face of the bottom substrate 11 of glass at the condition of having been arranged in all directions, and the counterelectrode is prepared in the base of crevice 11a. While consisting of a silicon wafer on the bottom [this] substrate 11, the substrate 12 has piled up.

[0004] Slot 12a is formed in the inside [this] substrate 12 of etching, and thin-walled part 12b which functions as diaphram is formed in the bottom wall of this slot 12a. This diaphram functions also as a common electrode and constitutes the counterelectrode and capacitor which were formed in the base of crevice 11a. the diaphram which diaphram deforms with a pressure and is produced by it when using as a pressure sensor, and the electrode which counters this — becoming — a pressure is measured by detecting change of the capacity of a capacitor electrically. moreover, the electrode which counters diaphram and this when using as an actuator of an ink jet head — becoming — by carrying out charge and discharge to a capacitor, a pressure will be given to the ink with which the ink interior of a room formed of slot 12a was filled up, and the regurgitation of the ink will be carried out from a nozzle.
[0005] The further glass upper substrate 13 piles up on the inside substrate 12.
[0006] Thus, the bottom substrate 11, the inside substrate 12, and the upper substrate 13 are mutually fixed with a junction fixture, where a laminating is carried out. The 1st impression electrode plate 21, the 2nd impression electrode plate 24, and the 3rd impression electrode 25 are formed in this junction fixture, respectively so that a predetermined electrical potential difference can be impressed to the bottom substrate 11, the inside substrate 12, and the upper substrate 13, respectively.
[0007] By carrying out the heating temperature up of each substrate to 250-350 degrees C with the above-mentioned junction fixture first, and connecting the impression electrode plate 21 of the above 1st, and the 3rd impression electrode 25 to a power source 14, in order to join The direct current voltage of hundreds of volts is first impressed between the bottom substrate 11 and the inside substrate 12, anode plate junction is performed, next a power source 15 is connected between the 2nd impression electrode plate 24 and the 3rd impression electrode 25, and anode plate junction to the inside substrate 12 and the upper substrate 13 is performed similarly. Thus, the pressure sensor or the zygote with which many ink jet heads were formed which makes thin-walled part 12b the oscillating section is completed, for example by joining the bottom substrate 11 and the upper substrate 13 to the both sides of the inside substrate 12. Behind, this zygote is divided into each pressure sensor or ink jet head by dicing etc.

[0008]
[Problem(s) to be Solved by the Invention] However, although it is necessary to consider as the condition of having positioned and contacted the substrate mutually and having piled it up in advance on the occasion of the above-mentioned anode plate junction Since the front face of a semi-conductor substrate or a glass substrate is formed in the high front face of a detergency, Although the contact condition of two substrates is determined by the hydrogen bond formed with the hydroxyl group on the front face of a substrate on the occasion of the 1st superposition by the bottom substrate 11 and the inside substrate 12, by the 2nd superposition by the same upper substrate 13 and the inside substrate 12 As a result of the contact condition by said 1st superposition changing and the inside substrate's 12 forming a new contact condition with the upper substrate 13, in order that it is influenced by the up-and-down substrate, and may bend, it may be distorted or the inside substrate 12 may carry out, There is a trouble of space occurring between mutual substrates or remaining as a poor junction field at the time of anode plate junction. The shape of detailed toothing in the front face of a semi-conductor substrate here Various patterning, In being formed by etching, a deposition technique, etc. and forming a pressure sensor, an ink jet head, etc. especially Since, as for the inside substrate 12 made from silicon, a very thin thin-walled part is thinly formed on a semi-conductor substrate compared with an up-and-down substrate, Of course, when laying the inside substrate 12 on the bottom substrate 11, when laying the upper substrate 13 on the inside substrate 12 after that, internal stress puffs up and remains in the inside substrate 12, and there is a problem of worsening the property of formation components, such as micro components.
[0009] The junction equipment 20 which shows the more concrete conventional junction approach to drawing 7 explains. In drawing 7 , first, the bottom substrate 11 as the 1st substrate and the substrate 12 while having thin-walled part 12a as the 2nd substrate are laid on the 1st impression electrode plate 21, respectively, and the upper substrate 13 as the 3rd substrate is further laid on the inside substrate 12 in piles.
[0010] Minus and the 3rd impression electrode 25 are considered [each substrate] after a heating temperature up and for the 1st impression electrode plate 21 as plus to 340 degrees C with the junction fixture of this condition, the direct current voltage of 800 volts is impressed between two electrodes, and anode plate junction to the bottom substrate 11 and the inside substrate 12 is performed. Next, 800 volts of direct currents were similarly impressed [the 2nd impression electrode plate 24] for minus and the 3rd impression electrode 25 as plus, and the anode plate junction to the upper substrate 13 and the inside substrate 12 was made to complete with 340 degrees C. Thus, it was in the condition that bending generates the condition of thin-walled part 12a of a substrate 12, and a predetermined property is not acquired about the component property as an ink jet head, either, while making it join.
[0011] While being laid on the bottom substrate 11, the uniform adhesion condition by the hydrogen bond between a substrate 12 and the bottom substrate 11 this It changes by having made the upper substrate 13 lay furthermore. The inside substrate 12 locally The result of hydrogen bond formation with the upper substrate 13, The inside substrate 12 is lifted and the stress depends poor adhesion on becoming bending and distortion and being generated in thin-walled part 12a, also in the time of a lifting and anode plate junction between the bottom substrates 11.
[0012] Although the approach of carrying out after [a heating temperature up] anode plate junction of the bottom substrate 11 and the inside substrate 12 as this solution means, and laying the cooling Gokami substrate 13 further and carrying out anode plate junction similarly can also be taken, a heating temperature up must be performed twice and it has the time-consuming fault.
[0013] Then, this invention solves the above-mentioned trouble, and the technical problem is in realizing the approach and junction equipment which carry out anode plate junction in the condition that internal stress does not remain, without bending and distortion arising in a substrate, when performing junction between the above 3 substrates.
[0014]
[Means for Solving the Problem] The means which this invention provided in order to solve the above-mentioned technical problem Three substrates of the 1st, 2nd, and 3rd substrates are set to superposition and the approach of joining. Hold, where the 1st and 2nd substrates are stuck, and the 3rd substrate is held in the state of non-contact to the upper part. It is the anode plate junction approach of the substrate which performs 1st anode plate junction between said 1st and 2nd substrates after a heating temperature up for said the 1st thru/or 3rd substrate, is made to carry out the press descent of said 3rd substrate on said 2nd set plate surface after that, and is characterized by performing 2nd anode plate junction between said 3rd substrate and said 2nd

[0015] About the quality of the material of the concrete substrate used for this approach, the 1st and 3rd substrates are glass substrates, and the 2nd substrate is a semi-conductor substrate. Moreover, the 2nd substrate is equipped with the thin-walled part which serves as diaphram locally. In this case, since the component property which it is easy to generate bending and distortion in a semi-conductor substrate by existence of a thin-walled part, and is manufactured by bending of that thin-walled part and distortion tends to receive effect, especially the thing for which the junction approach of this invention is used is effective.
[0016] Moreover, in order to raise the precision of junction, after said 1st, 2nd, and 3rd substrates have a front face defecated through RCA washing, being joined is desirable [the substrates] before junction. Next, the junction equipment of this invention sets three substrates of the 1st, 2nd, and 3rd substrates to superposition and the junction equipment which carries out anode plate junction. The 1st impression electrode which is laid where the 1st and 2nd substrates are stuck and which both touches said 1st substrate, In the condition that the inferior surface of tongue of the 3rd substrate countered above said 2nd substrate in the state of the top face of said 2nd substrate, and non-contact, and the two condition in the condition that the inferior surface of tongue of the 3rd substrate contacted the top face of said 2nd substrate The 2nd impression electrode which touches the top face of the supporter which supports said 3rd substrate, and said 3rd substrate supported by said supporter, The 3rd impression electrode which touches said 2nd substrate, and after said supporter has supported said 3rd substrate in the state of said 2nd substrate and non-contact, an electrical potential difference is impressed to said 1st and 3rd impression inter-electrode. It is characterized by having an electrical-potential-difference impression means to impress an electrical potential difference to said 2nd and 3rd impression inter-electrode where said 3rd substrate is supported in the state of said 2nd substrate and contact.
[0017] It is the bigger force as a desirable concrete means switches said 3rd substrate in the state of said 2nd substrate and contact condition, and non-contact, and support it than the energization force of an energization means energize said supporter up, and this energization means, and said 3rd substrate supported by said supporter is pressed caudad, this substrate is caudad moved with a supporter, and having said 2nd substrate and the press means to stick further is mentioned.
[0018] Moreover, it has at least one metal metallic ornaments which carry out press immobilization of said 2nd substrate supported by said 1st impression electrode in the condition of having been stuck with said 1st substrate more nearly locally than the upper part, and these metal metallic ornaments are arranged in the condition of having insulated with the 1st impression electrode plate, and you may make it function as 3rd impression electrode.
[0019]
[Embodiment of the Invention] Hereafter, the example which applied the junction approach of the substrate of this invention to the ink jet head is explained.
[0020] (An example of the ink jet head applied to this invention) Drawing 8 is the decomposition perspective view of the ink jet head which applied this invention. Moreover, drawing 9 is the assembled cross-section block diagram of an ink jet head.
[0021] As shown in these drawings, the ink jet head 100 is a face ink jet type which makes a liquid ink drop breathe out from the ink nozzle prepared in the top face of a substrate, and is the thing of an electrostatic drive method. The ink jet head 100 sandwiches the mold cavity plate 12 (an inside substrate, the 2nd substrate), and has a three-tiered structure which turned the nozzle plate 13 (an upper substrate, the 3rd substrate) up, and turned the laminating of the electrode substrate 11 (a bottom substrate, the 2nd substrate) down, respectively.
[0022] It is a silicon substrate and, as for the mold cavity plate 12, the crevice 107 which will constitute the ink room 106 where a bottom wall functions as a diaphragm 105 on the surface of a plate, the rill 109 which will form the ink feed hopper 108 prepared in the posterior part of a crevice 107, and the crevice 111 which will constitute the ink reservoir 110 for supplying ink to each ink room 106 are formed of etching. The inferior surface of tongue of this mold cavity plate 12 is graduated by mirror polishing.
[0023] The nozzle plate 13 joined to this mold cavity plate 12 bottom is a glass substrate or a silicon substrate. In the nozzle plate 13, two or more ink nozzles 121 which are open for free passage in each ink room 106 are formed in the part which has specified the top face of the ink room 106.
[0024] By joining this nozzle plate 13 to the mold cavity plate 12, the above-mentioned crevices 107 and 111 and a rill 109 are closed, and partition formation of each of the ink room 106, the ink feed hopper 108, and the ink reservoir 110 is carried out.
[0025] In addition, hole 112a for supplying ink is prepared in the ink reservoir 110, and the ink feed holes 112 are

substrate 11 mentioned later after substrate junction. It connects with a non-illustrated ink tank through a non-illustrated connection tube at the ink feed holes 112. The ink supplied from the ink feed holes 112 is supplied to each ink room 106 which became independent via each ink feed hopper 108.

[0026] The electrode substrates 11 joined to the mold cavity plate 12 bottom are silicon and a boro-silicated glass substrate with a near coefficient of thermal expansion. In this electrode substrate 11, the crevice 116 which will constitute the oscillating room (clearance) 115 is formed in the part which counters each diaphragm 105. The individual electrode 117 which counters a diaphragm 105 is formed in the base of this crevice 116. The individual electrode 117 has the segment polar zone 118 and terminal area 119 which consist of ITO.

[0027] By joining this electrode substrate 11 to the mold cavity plate 12, the segment polar zone 118 of a diaphragm 105 and the individual electrode 117 which has specified the base of each ink room 106 separates a slit very much, and counters. The closure of this clearance 115 is carried out with the sealing agent 120 arranged between the mold cavity plate 12 and the electrode substrate 11.

[0028] The diaphragm 105 is used as thin meat and elastic deformation is possible for it in the vertical direction in the direction of the outside of a field, i.e., drawing 9 . This diaphragm 105 functions as a common electrode by the side of each ink room. The non-dense water screen which consists of hexamethyldisilazane (HMDS) is formed in the base 151 of the diaphragm 105 as this common electrode. The non-dense water screen which consists of hexamethyldisilazane (HMDS) is formed also in the front face of the segment polar zone 118 of the individual electrode 117 which counters this diaphragm 105. It faces across a clearance 115 and the counterelectrode is formed of a diaphragm 105 and each corresponding segment polar zone 118.

[0029] Between the diaphragm 105 and the individual electrode 117, electrical-potential-difference impression equipment 125 is connected. One output of electrical-potential-difference impression equipment 125 is connected to the terminal area 119 of the electrode 117 according to each, and the output of another side is connected to the common electrode terminal 126 formed in the mold cavity plate 12. Since mold cavity plate 12 the very thing has conductivity, it can supply an electrical potential difference to a diaphragm (common electrode) 105 from this common electrode terminal 126. Moreover, what is necessary is just to form the thin film of conductive ingredients, such as gold, in one field of the mold cavity plate 12 by vacuum evaporationo or sputtering, when an electrical potential difference needs to be supplied to a diaphragm 105 with lower electric resistance. In this example, in order to use anode plate junction for connection between the mold cavity plate 12 and the electrode substrate 11, the electric conduction film is formed in the passage forming face side of the mold cavity plate 12.

[0030] Thus, in the constituted ink jet head 1, if the driver voltage from electrical-potential-difference impression equipment 25 is impressed between counterelectrodes, the Coulomb force by the charge charged between counterelectrodes occurs, a diaphragm 105 will bend to the segment polar-zone 118 side, and the volume of the ink room 105 will expand it. Next, if the driver voltage from electrical-potential-difference impression equipment 125 is canceled and the charge between counterelectrodes is discharged, a diaphragm 105 will return according to the elastic return force, and the volume of the ink room 106 will contract it rapidly. By internal pressure fluctuation generated at this time, some ink stored by the ink room 106 carries out the regurgitation toward the recording paper from the ink nozzle 121 which is open for free passage in the ink room 106.

[0031] In addition, as ink used with the ink jet head 100, it is prepared by making the main solvents, such as water, alcohol, and toluene, dissolve or distribute a surfactant, and a color or pigments, such as ethylene glycol. Furthermore, if the heater is formed in the ink jet head 1, hot melt ink can also be used.

[0032] (The junction equipment of this invention, 1 operation gestalt of the junction approach) Next, the gestalt of operation of the anode plate junction approach which starts this invention with reference to drawing 1 and drawing 2 , and junction equipment is explained. Each operation gestalt shown below is the anode plate junction approach or equipment of the semi-conductor substrate and glass substrate which were constituted so that it might use on the occasion of manufacture of the ink jet head mentioned above. As long as there is especially no notice, the same sign puts the same thing.

[0033] However, in this invention, it is possible not only the anode plate junction to a semi-conductor substrate and a glass substrate but to apply to junction of semi-conductor substrates or other quality of the materials.

[0034] drawing 1 — the — one — operation — a gestalt — it can set — junction — equipment — structure — being shown — a top view — (— b —) — a top view — AA — ' — it can set — an outline — drawing of longitudinal section — (— a —) — it is . This operation gestalt consists of a support attaching part 23 energized

plate 21, and the 2nd impression electrode plate 24.
[0035] First, the bottom substrate 11 (1mm in appearance 3inchphi, thickness) of glass [which was washed by clarification from the substrate feed zone which is not illustrated] is laid on the 1st impression electrode plate 21 with the adsorption maintenance means which similarly is not illustrated. Next, adsorption maintenance of the inside substrate 12 (0.18mm in appearance 3inchphi, thickness) made from the semi-conductor washed by clarification is similarly carried out with an adsorption maintenance means, alignment is performed by well-known approaches, such as an image processing, on the basis of the alignment mark formed on the front face of a bottom substrate, and it lays on the bottom substrate 11. In addition, two or more diaphragms with a 350micrometerx6.5mm and a thickness of 13 micrometers are formed in the inside substrate 12 as thin-walled part 12a. Moreover, since both the substrate 12 and the bottom substrate 11 are processed on the clean surface inside at this time, adhesion immobilization is exactly carried out by the hydrogen bond force of the moisture which exists in both the substrates front face, or surface water acid radicals on the bottom substrate 11. Moreover, by carrying out press maintenance of the two places with the 3rd impression electrode 25 in [top / inside substrate 12] this case, fixed maintenance of the bottom substrate 11 and the inside substrate 12 is carried out in the condition of having stuck at the 1st impression electrode plate 21.
[0036] Next, the upper substrate 13 (1mm in size of 90x50mm, thickness) washed by clarification is laid on the support attaching part 23 by the same approach. Since the support attaching part 23 is energized up with the coil spring 22, the upper substrate 13 is held in the state of un-sticking to the inside substrate 12. Next, the 2nd impression electrode plate 24 is put on the upper substrate 13. Even if it is this case, the upper substrate 13 has given the energization reinforcement which can maintain the condition to the inside substrate 12 of not sticking to the support attaching part 23 with the coil spring 22.
[0037] Next, after carrying out the heating temperature up of the junction fixture 20 with which three substrates were set to 340 degrees C, the direct current voltage of 800 volts is impressed for 10 minutes, using minus potential and the 3rd impression electrode plate 25 as plus potential for the 1st impression electrode plate 21, 1st anode plate junction to the bottom substrate 11 and the inside substrate 12 is performed, and junction of both substrates is completed.
[0038] The 2nd impression electrode plate 24 is pressed until the upper substrate 13 sticks to the inside substrate 12 by the press bearing bar 26 to which the junction fixture 20 was furthermore connected possible [rise and fall] in the condition of having been held at 340 degrees C, according to devices, such as the driving means which does not illustrate the 2nd impression electrode plate 24, for example, a hydrostatic pressure cylinder etc., as shown in drawing 2 . In this case, the thrust more than the energization reinforcement of a coil spring 22 is applied to the press bearing bar 26.
[0039] And the direct current voltage of 800 volts is impressed using minus potential and the 3rd impression electrode 25 as plus potential for the 2nd impression electrode plate 24 like said procedure, and the permanent junction to the upper substrate 13 as the 2nd anode plate junction and the inside substrate 12 is made to complete.
[0040] The junction which completes the anode plate junction to the bottom substrate 11, therefore does not have stress is possible, without receiving the complicated stress from the upper substrate 13 and both the substrates of the bottom substrate 11, since according to this operation gestalt anode plate junction is carried out while having the thin-walled part by which installation adhesion was carried out on the bottom substrate 11 and the substrate 12 had been held at the upper substrate 13 and the non-contact condition. In the condition after the 1st anode plate junction, since it is firmly fixed to up to the bottom substrate 11 (i.e., since junction immobilization of the thin-walled part on the inside substrate 12 is carried out in the perimeter), the inside substrate 12 receives neither bending nor distortion also by the press from the upper part of the subsequent upper substrate 13.
[0041] Thus, as a result of investigating the condition of the diaphram of the inside substrate 12 made from the semi-conductor in the obtained zygote, it was in the good condition without bending or distortion, and the component property as an ink jet head was good similarly.
[0042] (The junction equipment of this invention, other operation gestalten of the junction approach)
(The 2nd operation gestalt) Next, the 2nd operation gestalt concerning this invention is explained using drawing 3 and drawing 4 . In this operation gestalt, as shown in drawing 3 , the support attaching part 23 is carrying out the configuration which functions also as an object for immobilization of the 2nd impression electrode plate 24.
[0043] The above-mentioned junction fixture 20 makes the bottom substrate 11 and the inside substrate 12 lay

substrate 13 lay on the support attaching part 23. Furthermore, the 2nd impression electrode plate 24 is put using the stanchion 27 of the support attaching part 23, and the heating temperature up of the junction fixture 20 is carried out to 340 degrees C.

[0044] Next, by pressing the 2nd impression electrode plate 24 with the press rod 26 the drive which carries out anode plate junction and does not illustrate the bottom substrate 11 and the inside substrate 12 after that by direct-current-voltage impression, as shown in drawing 4 , the upper substrate 13 is stuck to up to the inside substrate 12.

[0045] Finally the direct-current high voltage is impressed to the inside substrate 12 and the upper substrate 13 in the condition which shows in drawing 4 , and the anode plate junction between the inside substrate 12 and the upper substrate 13 is completed.

[0046] Thus, when the diaphram 105 of a substrate 12 was observed while being joined, it was in the good condition without bending or distortion, and the component property as an ink jet head was good similarly.

[0047] (The 3rd operation gestalt) Drawing 5 explains the 3rd operation gestalt below. As this operation gestalt is shown in drawing 5 , three upper substrates 13 are joined to the inside substrate 12 of one. Moreover, three impression electrode plates 24a, 24b, and 24c which are equivalent to the 2nd impression electrode plate 24 at the configuration of the upper substrates 13a, 13b, and 13c, and are caudad pressed independently with a coil spring, respectively are attached.

[0048] The bottom substrate 11 and the inside substrate 12 are made to lay on the 1st impression electrode plate first, respectively, and, next, the upper substrates 13a, 13b, and 13c are made to lay on the support attaching parts 23a and 23b and 23c. Furthermore the 2nd impression electrode plate 24 is put, and the heating temperature up of the junction fixture 20 is carried out to 340 degrees C like the 2nd operation gestalt below.

[0049] Next, anode plate junction of the bottom substrate 11 and the inside substrate 12 is carried out by direct-current-voltage impression like the 2nd operation gestalt, and the upper substrates 13a, 13b, and 13c are stuck to up to the inside substrate 12 by pressing the 2nd impression electrode plate 24 with the press rod 26 the rear axle style. In this case, since each impression electrode plates 24a, 24b, and 24c are attached independently, respectively, even if a substrate thickness difference is in the upper substrates 13a, 13b, and 13c, the adhesion to the inside substrate 12 is possible.

[0050] Direct current voltage is impressed to the inside substrate 12 and the upper substrates 13a, 13b, and 13c, and junction is completed.

[0051] Thus, when the diaphram 105 of a substrate 12 was observed while being joined, it was in the good condition without bending or distortion, and the property as an ink jet head was good similarly.

[0052] Although each operation gestalt explained taking the case of the case where join the bottom substrate 11 of glass, and the inside substrate 12 of silicon, and the further glass upper substrate 13 is joined, you may be the case where use and make a semi-conductor substrate the upper substrate 13, and direct junction by other junction means, for example, silicon substrates, is performed.

[0053]

[Effect of the Invention] According to this invention, the following effectiveness is done so as explained above.

[0054] According to the junction approach of this invention, and junction equipment, support maintenance of the 3rd substrate is carried out in the state of non-contact on the 2nd substrate. After it carries out a heating temperature up and the 1st of the 1st substrate and the 2nd substrate carries out anode plate junction, in order to stick the 3rd substrate on the 2nd substrate and to perform anode plate junction between the 2nd substrate and the 3rd substrate, Stress which joins the 2nd substrate can be made into min, and the zygote with which internal stress does not remain in the 2nd substrate after anode plate junction can be formed.

[0055] Since the component property which it is easy to generate bending and distortion in a semi-conductor substrate by existence of thin meat, and is manufactured by bending of the thin-walled part and distortion tends to wear a bad influence when especially the 2nd substrate has thin-walled parts, such as diaphram, thinly and locally compared with other substrates, especially this invention is effective.

[0056] Although this operation gestalt explained taking the case of the case where join the bottom substrate 11 and the inside substrate 12, and the upper substrate 13 is joined further, you may be the case where direct junction by other junction means, for example, silicon substrates, is performed as a semi-conductor substrate instead of the upper substrate 13.

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Outline drawing of longitudinal section (a) and the outline plan (b) in AA'cross section of the plan showing the 1st operation gestalt concerning this invention.
[Drawing 2] Outline drawing of longitudinal section showing the condition before the 2nd anode plate junction in the 1st operation gestalt concerning this invention.
[Drawing 3] The outline sectional view (a) and outline plan (b) in AA'cross section of the plan in the 2nd operation gestalt concerning this invention.
[Drawing 4] Outline drawing of longitudinal section showing the condition before the 2nd anode plate junction in the 2nd operation gestalt concerning this invention.
[Drawing 5] The outline sectional view (A) and outline plan (b) in the plan AA'cross section in the 3rd operation gestalt concerning this invention.
[Drawing 6] Outline drawing of longitudinal section showing the condition before the 2nd anode plate junction in the 3rd operation gestalt concerning this invention.
[Drawing 7] The approximate account Fig. showing the condition of the substrate junction by the anode plate junction in the production process of an ink jet head.
[Drawing 8] The perspective view showing an example of the ink jet head to which this invention is applied.
[Drawing 9] The sectional view of the ink jet head shown in drawing 8 .
[Description of Notations]
11 Bottom Substrate
12 Inside Substrate
13 Upper Substrate 20 Junction Equipment (Fixture)
21 1st Impression Electrode Plate
22 Coil Spring
23 Support Attaching Part
24 2nd Impression Electrode Plate
25 3rd Impression Electrode
26 Press Pin

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平11－192712

(43)公開日　平成11年(1999)７月21日

(51)Int.Cl.[6]	識別記号	ＦＩ	
Ｂ４１Ｊ　2/16		Ｂ４１Ｊ　3/04	１０３Ｈ
Ｃ０３Ｃ　27/02		Ｃ０３Ｃ　27/02	Ｚ

審査請求　未請求　請求項の数７　ＯＬ　（全９頁）

(21)出願番号　特願平10－35

(22)出願日　平成10年(1998)１月５日

(71)出願人　000002369
セイコーエプソン株式会社
東京都新宿区西新宿２丁目４番１号

(72)発明者　前田　佳男
長野県諏訪市大和３丁目３番５号　セイコーエプソン株式会社内

(72)発明者　小松　洋
長野県諏訪市大和３丁目３番５号　セイコーエプソン株式会社内

(72)発明者　清水　信雄
長野県諏訪市大和３丁目３番５号　セイコーエプソン株式会社内

(74)代理人　弁理士　鈴木　喜三郎　(外２名)

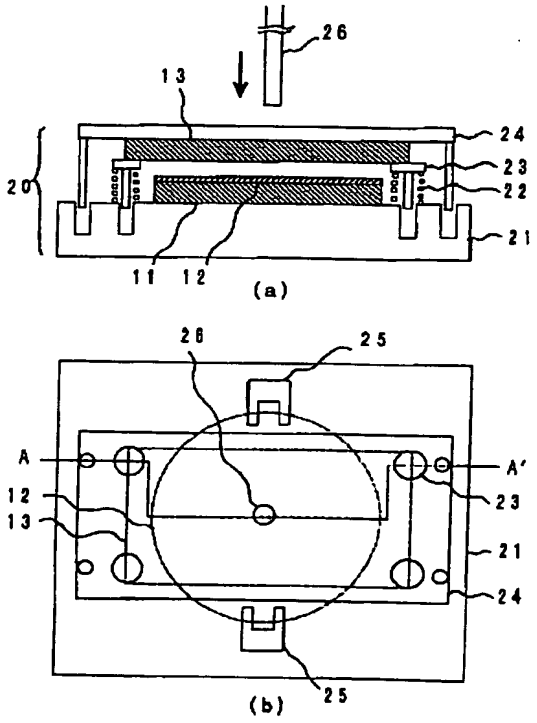
最終頁に続く

(54)【発明の名称】　基板の陽極接合方法及び基板の接合装置

(57)【要約】

【課題】３枚の基板を陽極接合する場合に、上下基板に挟まれる中央基板に歪みがない状態として陽極接合する方法を実現する。

【解決手段】　接合装置２０は第１の印加電極板２１と、コイルバネ２２により上方に付勢された支持保持部２３と、第２の印加電極板２４及び第３の印加電極とを備えている。下基板１１と中基板１２密着した状態で保持しこれらの基板を接合する第１の陽極接合を行った後、第１の陽極接合時に昇温された同じ加熱状態のもとで、上基板１３を中基板１２に押圧密着させ第２の陽極接合を行う。



【特許請求の範囲】

【請求項１】　第１、第２及び第３基板の３枚の基板を重ね合わせ、接合する方法において、第１及び第２基板とを密着させた状態で保持し、その上方に第３基板を非接触状態で保持し、前記第１乃至第３の基板を加熱昇温後、前記第１及び第２基板間の第１の陽極接合を行い、その後に前記第３基板を前記第２基板面上に押圧下降させ、前記第３基板と前記第２基板間の第２の陽極接合を行うことを特徴とする基板の陽極接合方法。

【請求項２】　請求項１において前記第１及び第３基板はガラス基板であり、第２基板は半導体基板であることを特徴とする基板の陽極接合方法。

【請求項３】　請求項２において、前記第２基板は、局所的にダイヤフラムとなる薄肉部を備えた半導体基板であることを特徴とする基板の陽極接合方法。

【請求項４】　請求項２において前記第１、第２及び第３基板はＲＣＡ洗浄を経て表面を清浄化された後、接合されることを特徴とする基板の陽極接合方法。

【請求項５】　第１、第２及び第３基板の３枚の基板を重ね合わせ、陽極接合する接合装置において、

第１及び第２基板を密着させた状態で載置する共に、前記第１の基板に接する第１の印加電極と、

前記第２の基板の上方に、第３基板の下面が前記第２基板の上面と非接触状態で対向した状態と、第３基板の下面が前記第２基板の上面と接触した状態の２つの状態で、前記第３の基板を支持する支持部と、

前記支持部に支持された前記第３基板の上面に接する第２の印加電極と、

前記第２の基板に接する第３の印加電極と、

前記支持部が、前記第３基板を前記第２基板と非接触状態で支持した状態で前記第１、第３印加電極間に電圧を印加し、前記第３基板を前記第２基板と接触状態で支持した状態で前記第２、第３印加電極間に電圧を印加する電圧印加手段とを有することを特徴とする基板の陽極接合装置。

【請求項６】　請求項５記載の陽極接合装置において、前記支持部を上方に付勢する付勢手段と、該付勢手段の付勢力より大きな力で、前記支持部に支持された前記第３の基板を下方に押圧し、該基板を支持部と共に下方に移動させ、前記第２の基板と密着させる押圧手段を備えたことを特徴とする基板の陽極接合装置。

【請求項７】　請求項５記載の陽極接合装置において、前記第１の基板と密着された状態で前記第１の印加電極に支持された前記第２基板を、上方より局部的に押圧固定する少なくとも１つの金属金具を有し、且つ該金属金具は第１の印加電極板と絶縁された状態で配置されており、第３の印加電極として機能することを特徴とする基板の陽極接合装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は基板の接合方法及び接合装置に係り、特に３層基板の陽極接合を行うに際して、好適な陽極接合方法及び接合するための装置もしくは治具に関する。

【０００２】

【従来の技術】従来、半導体基板同士や半導体基板とガラス基板とを接合するための種々の技術が知られている。例えばマイクロマシニング分野においては、シリコンウエハ（以下、半導体基板ともいう。）とホウケイ酸ガラス基板（以下、単にガラス基板ともいう。）とを接触させ、この状態で陽極接合により半導体基板とガラス基板とを接合する技術があり、この技術により圧力センサ、インクジェットヘッド等の種々のマイクロ部品を製造する試みがなされている。

【０００３】図７はこのような陽極接合技術を用いたインクジェットヘッドの製造装置を示すものである。ガラス製の下基板１１の表面には表面凹部１１ａが縦横に配列された状態に多数形成されており、凹部１１ａの底面には対向電極が設けられている。この下基板１１の上にはシリコンウエハから成る中基板１２が重ねられている。

【０００４】この中基板１２には例えばエッチングにより溝１２ａが形成され、この溝１２ａの底壁にはダイヤフラムとして機能する薄肉部１２ｂが形成されている。このダイヤフラムは共通電極としても機能し、凹部１１ａの底面に設けられた対向電極とキャパシタを構成する。圧力センサとして用いる場合は、圧力によってダイヤフラムが変形し、それによって生じるダイヤフラムとこれに対向する電極かなるらキャパシタの容量の変化を電気的に検出することにより圧力を計測する。また、インクジェットヘッドのアクチュエータとして用いる場合は、ダイヤフラムとこれに対向する電極かなるらキャパシタに充放電することにより、溝１２ａによって形成されるインク室内に充填されたインクに圧力を与えてノズルからインクを吐出することになる。

【０００５】中基板１２の上にはさらにガラス製の上基板１３が重ねられる。

【０００６】このようにして、下基板１１、中基板１２及び上基板１３が積層された状態で、接合治具によって相互に固定する。この接合治具には、下基板１１、中基板１２及び上基板１３にそれぞれ所定の電圧を印加できるように第１の印加電極板２１と、第２の印加電極板２４及び第３の印加電極２５とがそれぞれ設けられている。

【０００７】接合するには、先ず上記接合治具と共に各基板を２５０～３５０℃に加熱昇温し、上記第１の印加電極板２１と第３の印加電極２５とを電源１４に接続することにより、まず下基板１１と中基板１２との間に数百ボルトの直流電圧を印加し、陽極接合を行い、次に、第２の印加電極板２４と第３の印加電極２５との間に電

源１５を接続して、中基板１２と上基板１３との陽極接合を同様に行う。このようにして中基板１２の両側に下基板１１、上基板１３が接合されることによって、薄肉部１２ｂを振動部とする例えば圧力センサ、もしくはインクジェットヘッドが多数形成された接合体が完成する。この接合体は後に、ダイシング等によって個々の圧力センサもしくはインクジェットヘッドに分離される。

【０００８】

【発明が解決しようとする課題】しかしながら、上記陽極接合に際して、事前に基板を相互に位置決めし、接触させて重ね合わせた状態とする必要があるが、半導体基板やガラス基板の表面を清浄性の高い表面に形成しているため、下基板１１と中基板１２とによる第１の重ね合わせに際しては基板表面の水酸基により形成される水素結合により２枚の基板の接触状態が決定されるものの、同様な上基板１３と中基板１２とによる第２の重ね合わせにより、前記第１の重ね合わせによる接触状態が変化し、中基板１２が上基板１３との新たな接触状態を形成する結果、中基板１２が上下の基板より影響を受け撓んだり歪んだりするため、相互の基板間に空間が発生したり、陽極接合時に接合不良領域として残存したりするという問題点がある。ここで、半導体基板の表面には微細な凹凸形状が各種パターニング、エッチング、堆積技術等によって形成されており、特に圧力センサやインクジェットヘッド等を形成する場合には、シリコン製の中基板１２は上下の基板に比べ薄く、また極めて薄い薄肉部が半導体基板上に形成されるため、下基板１１上に中基板１２を載置する時はもちろん、その後に上基板１３を中基板１２上に載置する時に、中基板１２に内部応力が増長、残存し、マイクロ部品等の形成素子の特性を悪化させてしまうという問題がある。

【０００９】より具体的な従来の接合方法を図７に示す接合装置２０にて説明する。図７では、先ず第１の基板としての下基板１１と、第２の基板としての薄肉部１２ａを有する中基板１２とをそれぞれ第１の印加電極板２１上に載置し、さらに第３の基板としての上基板１３を重ねて中基板１２上に載置する。

【００１０】この状態の接合治具とともに各基板を３４０℃まで加熱昇温後、第１の印加電極板２１をマイナス、第３の印加電極２５をプラスとし両電極間に８００ボルトの直流電圧を印加し、下基板１１と中基板１２との陽極接合を行う。次に３４０℃のままで、第２の印加電極板２４をマイナス、第３の印加電極２５をプラスとして同様に直流８００ボルトを印加して上基板１３と中基板１２との陽極接合を完了させた。このように接合させた中基板１２の薄肉部１２ａの状態は撓みが発生し、インクジェットヘッドとしての素子特性についても所定の特性が得られない状態であった。

【００１１】これは下基板１１上に載置された中基板１２と下基板１１間の水素結合による均一な密着状態が、さらに上基板１３を載置させたことにより変化し、局部的には中基板１２が上基板１３との水素結合形成の結果、中基板１２が持ち上げられ下基板１１との間で密着不良を起こし、陽極接合時でもその応力が薄肉部１２ａに撓みや歪みとなって生ずることによるものである。

【００１２】この解決手段として下基板１１と中基板１２とを加熱昇温後陽極接合し、さらに冷却後上基板１３を載置し同様に陽極接合する方法もとりうるものの、加熱昇温を２回行わなければならず、手間がかかる欠点を有している。

【００１３】そこで本発明は上記問題点を解決するものであり、その課題は、上記のような３基板間の接合を行う場合に、基板に撓みや歪みが生ずることなく、内部応力が残存しない状態で陽極接合する方法及び接合装置を実現することにある。

【００１４】

【課題を解決するための手段】上記課題を解決するために本発明が講じた手段は、第１、第２及び第３基板の３枚の基板を重ね合わせ、接合する方法において、第１及び第２基板とを密着させた状態で保持し、その上方に第３基板を非接触状態で保持し、前記第１乃至第３の基板を加熱昇温後、前記第１及び第２基板間の第１の陽極接合を行い、その後に前記第３基板を前記第２基板面上に押圧下降させ、前記第３基板と前記第２基板間の第２の陽極接合を行うことを特徴とする基板の陽極接合方法である。

【００１５】この方法に用いられる具体的な基板の材質については、第１及び第３基板はガラス基板であり、第２基板は半導体基板である。また、第２基板には、局所的にダイヤフラムとなる薄肉部を備えている。この場合には薄肉部の存在によって半導体基板に撓みや歪みが発生し易く、またその薄肉部の撓みや歪みによって製造される素子特性が影響を被り易いので、本発明の接合方法を用いることが特に効果的である。

【００１６】また、接合の精度を高めるために、接合前に、前記第１、第２及び第３基板はＲＣＡ洗浄を経て表面を清浄化された後、接合されることが望ましい。　次に、本発明の接合装置は、第１、第２及び第３基板の３枚の基板を重ね合わせ、陽極接合する接合装置において、第１及び第２基板を密着させた状態で載置する共に、前記第１の基板に接する第１の印加電極と、前記第２の基板の上方に、第３基板の下面が前記第２基板の上面と非接触状態で対向した状態と、第３基板の下面が前記第２基板の上面と接触した状態の２つの状態で、前記第３の基板を支持する支持部と、前記支持部に支持された前記第３基板の上面に接する第２の印加電極と、前記第２の基板に接する第３の印加電極と、前記支持部が、前記第３基板を前記第２基板と非接触状態で支持した状態で前記第１、第３印加電極間に電圧を印加し、前記第３基板を前記第２基板と接触状態で支持した状態で前記

第２、第３印加電極間に電圧を印加する電圧印加手段とを有することを特徴とする。

【００１７】前記第３基板を前記第２基板と接触状態、非接触状態で切り換えて支持する好ましい具体的な手段としては、前記支持部を上方に付勢する付勢手段と、該付勢手段の付勢力より大きな力で、前記支持部に支持された前記第３の基板を下方に押圧し、該基板を支持部と共に下方に移動させ、前記第２の基板と密着させる押圧手段を更に備えることが挙げられる。

【００１８】また、前記第１の基板と密着された状態で前記第１の印加電極に支持された前記第２基板を、上方より局部的に押圧固定する少なくとも１つの金属金具を有し、且つ該金属金具は第１の印加電極板と絶縁された状態で配置されており、第３の印加電極として機能するようにしてもよい。

【００１９】

【発明の実施の形態】以下、本発明の基板の接合方法をインクジェットヘッドに適用した例について説明する。

【００２０】（本発明に適用されるインクジェットヘッドの一例）図８は本発明を適用したインクジェットヘッドの分解斜視図である。また、図９は組み立てられたインクジェットヘッドの断面構成図である。

【００２１】これらの図に示すように、インクジェットヘッド１００は、インク液滴を基板の上面に設けたインクノズルから吐出させるフェイスインクジェットタイプであり、静電駆動方式のものである。インクジェットヘッド１００は、キャビティープレート１２（中基板、第２の基板）を挟み、上側にノズルプレート１３（上基板、第３の基板）、下側に電極基板１１（下基板、第２の基板）がそれぞれ積層された３層構造となっている。

【００２２】キャビティープレート１２は、例えばシリコン基板であり、プレートの表面には底壁が振動板１０５として機能するインク室１０６を構成することになる凹部１０７と、凹部１０７の後部に設けられたインク供給口１０８を形成することになる細溝１０９と、各々のインク室１０６にインクを供給するためのインクリザーバ１１０を構成することになる凹部１１１とがエッチングによって形成されている。このキャビティープレート１２の下面は鏡面研磨によって平滑化されている。

【００２３】このキャビティープレート１２の上側に接合されるノズルプレート１３は、例えばガラス製の基板、もしくはシリコン基板である。ノズルプレート１３において、インク室１０６の上面を規定している部分には各インク室１０６に連通する複数のインクノズル１２１が形成されている。

【００２４】このノズルプレート１３をキャビティープレート１２に接合することにより、上記の凹部１０７、１１１、および細溝１０９が塞がれて、インク室１０６、インク供給口１０８、インクリザーバ１１０のそれぞれが区画形成される。

【００２５】なお、インクリザーバ１１０の底面を規定する部分にはインクリザーバ１１０にインクを供給するための孔１１２ａが設けられており、基板接合後、後述する電極基板１１に設けられた孔１１２ｂと共にインク供給孔１１２を形成する。インク供給孔１１２には、不図示の接続チューブを介して不図示のインクタンクに接続される。インク供給孔１１２から供給されたインクは、各インク供給口１０８を経由して独立した各インク室１０６に供給される。

【００２６】キャビティープレート１２の下側に接合される電極基板１１は、シリコンと熱膨張率が近いホウ珪酸ガラス基板である。この電極基板１１において、各々の振動板１０５に対向する部分には振動室（隙間）１１５を構成することになる凹部１１６が形成されている。この凹部１１６の底面には、振動板１０５に対向する個別電極１１７が形成されている。個別電極１１７は、ＩＴＯからなるセグメント電極部１１８と端子部１１９を有している。

【００２７】この電極基板１１をキャビティープレート１２に接合することにより、各インク室１０６の底面を規定している振動板１０５と個別電極１１７のセグメント電極部１１８は、非常に狭い隙間を隔てて対向する。この隙間１１５はキャビティープレート１２と電極基板１１の間に配置した封止材１２０によって封止される。

【００２８】振動板１０５は薄肉とされており、面外方向、すなわち、図９において上下方向に弾性変形可能となっている。この振動板１０５は、各インク室側の共通電極として機能する。この共通電極としての振動板１０５の底面１５１にはヘキサメチルジシラザン（ＨＭＤＳ）からなる疎水膜が形成されている。この振動板１０５に対向する個別電極１１７のセグメント電極部１１８の表面にも、ヘキサメチルジシラザン（ＨＭＤＳ）からなる疎水膜が形成されている。隙間１１５を挟み、振動板１０５と、対応する各セグメント電極部１１８とによって対向電極が形成されている。

【００２９】振動板１０５と個別電極１１７との間には電圧印加装置１２５が接続されている。電圧印加装置１２５の一方の出力は各個別電極１１７の端子部１１９に接続され、他方の出力はキャビティープレート１２に形成された共通電極端子１２６に接続されている。キャビティープレート１２自体は導電性をもつため、この共通電極端子１２６から振動板（共通電極）１０５に電圧を供給することができる。また、より低い電気抵抗で振動板１０５に電圧を供給する必要がある場合には、例えば、キャビティープレート１２の一方の面に金等の導電性材料の薄膜を蒸着やスパッタリングで形成すれば良い。本例では、キャビティープレート１２と電極基板１１との接続に陽極接合を用いるために、キャビティープレート１２の流路形成面側に導電膜を形成してある。

【００３０】このように構成したインクジェットヘッド

１においては、電圧印加装置２５からの駆動電圧が対向電極間に印加されると、対向電極間に充電された電荷によるクーロン力が発生し、振動板１０５はセグメント電極部１１８の側へ撓み、インク室１０５の容積が拡大する。次に、電圧印加装置１２５からの駆動電圧を解除して対向電極間の電荷を放電すると、振動板１０５はその弾性復帰力によって復帰し、インク室１０６の容積が急激に収縮する。この時発生する内圧変動により、インク室１０６に貯留されたインクの一部が、インク室１０６に連通しているインクノズル１２１から記録紙に向かって吐出する。

【００３１】なお、インクジェットヘッド１００で使用されるインクとしては、水、アルコール、トルエン等の主溶媒にエチレングリコール等の界面活性剤と、染料または顔料とを溶解または分散させることにより調製される。さらに、インクジェットヘッド１にヒータを設けておけば、ホットメルトインクも使用できる。

【００３２】（本発明の接合装置、接合方法の一実施形態）次に、図１、図２を参照して本発明に係る陽極接合方法及び接合装置の実施の形態について説明する。以下に示す各実施形態は、前述したインクジェットヘッドの製造に際して用いるように構成された半導体基板とガラス基板との陽極接合方法或いは装置である。特に断りがない限り、同一の符号は同一のものをさす。

【００３３】しかし、本発明においては、半導体基板とガラス基板との陽極接合に限らず、半導体基板同士、或いは他の材質の接合にたいしても適用することも可能である。

【００３４】図１は第１実施形態における接合装置の構造を示す平面図（ｂ）と平面図のＡＡ´における概略縦断面図（ａ）である。本実施形態は第１の印加電極板２１と、第１の印加電極板２１に取り付けられたコイルバネ２２によって上方に付勢された支持保持部２３と、第２の印加電極板２４とから構成される。

【００３５】まず、図示しない基板供給部から清浄に洗浄されたガラス製の下基板１１（外形３インチφ、厚さ１ｍｍ）を、同じく図示しない吸着保持手段により第１の印加電極板２１上に載置する。次に清浄に洗浄された半導体製の中基板１２（外形３インチφ、厚さ０．１８ｍｍ）を同様に吸着保持手段により吸着保持し、下基板の表面上に形成された位置合わせマーク等を基準として画像処理等の公知の方法により位置合わせを行い、下基板１１上に載置する。尚中基板１２には薄肉部１２ａとして３５０μｍ×６．５ｍｍ、厚さ１３μｍの複数のダイアフラムが形成してある。またこの時中基板１２と下基板１１は共に清浄な表面に加工されているので、両基板表面に存在する水分または表面水酸基同士の水素結合力により下基板１１上にぴったりと密着固定される。またこの場合第３の印加電極２５により中基板１２上より２箇所が押圧保持されることにより、下基板１１と中基板１２は密着した状態で第１の印加電極板２１に固定保持される。

【００３６】次に清浄に洗浄された上基板１３（サイズ９０×５０ｍｍ、厚さ１ｍｍ）を同様な方法により支持保持部２３上に載置する。支持保持部２３はコイルバネ２２により上方に付勢されているので上基板１３は中基板１２へは非密着状態で保持される。次に上基板１３上に第２の印加電極板２４を被せる。この場合であっても上基板１３が中基板１２への非密着状態を維持できうるだけの付勢強度をコイルバネ２２によって支持保持部２３に持たせてある。

【００３７】次に３基板がセットされた接合治具２０を３４０℃に加熱昇温した後、第１の印加電極板２１をマイナス電位、第３の印加電極板２５をプラス電位として８００ボルトの直流電圧を１０分間印加し、下基板１１と中基板１２との第１の陽極接合を行い、両基板の接合を完了する。

【００３８】さらに接合治具２０が３４０℃に保持された状態で、第２の印加電極板２４を図示しない駆動手段、例えば流体圧シリンダー等の機構により昇降可能に接続された押圧支持棒２６により、図２に示すように上基板１３が中基板１２に密着するまで第２の印加電極板２４を押圧する。この場合にはコイルバネ２２の付勢強度以上の押圧力を押圧支持棒２６に加える。

【００３９】そして、前記手順と同様に第２の印加電極板２４をマイナス電位、第３の印加電極２５をプラス電位として８００ボルトの直流電圧を印加して第２の陽極接合としての上基板１３と中基板１２との永久接合を完了させる。

【００４０】本実施形態によれば、下基板１１上に載置密着された薄肉部を有する中基板１２は、上基板１３と非接触状態に保持されたまま陽極接合されるため、上基板１３と下基板１１の両基板とからの複雑な応力を受けることなく、下基板１１との陽極接合を完了し、従って応力のない接合が可能である。第１の陽極接合後の状態では中基板１２は下基板１１上へ強固に固定されているため、すなわち中基板１２上の薄肉部はその周囲を接合固定されているため、その後の上基板１３の上方からの押圧によっても撓みや歪みを受けることはない。

【００４１】このように、得られた接合体での半導体製の中基板１２のダイヤフラムの状態を調べた結果、撓みや歪みの無い良好な状態であり、インクジェットヘッドとしての素子特性も同様に良好であった。

【００４２】（本発明の接合装置、接合方法の他の実施形態）

（第２実施形態）次に、図３，図４を用いて、本発明に係わる第２実施形態について説明する。この実施形態においては、図３に示すように、支持保持部２３が第２の印加電極板２４の固定用としても機能する構成をしている。

【００４３】上記接合治具２０は第１実施形態と同様に下基板１１と中基板１２とをそれぞれ第１の印加電極板２１上に載置させ、次に上基板１３を支持保持部２３上に載置させる。さらに第２の印加電極板２４を支持保持部２３の支柱２７を利用して被せ、接合治具２０を３４０℃まで加熱昇温する。

【００４４】次に下基板１１と中基板１２とを直流電圧印加によって陽極接合し、その後図示しない駆動機構により押圧棒２６により第２の印加電極板２４を押圧することにより、図４に示すように上基板１３を中基板１２上へ密着させる。

【００４５】最後に、図４に示す状態にて中基板１２と上基板１３とに直流高電圧を印加し、中基板１２と上基板１３間の陽極接合を完了する。

【００４６】このようにして接合された中基板１２のダイヤフラム１０５を観察したところ、撓みや歪みの無い良好な状態であり、インクジェットヘッドとしての素子特性も同様に良好であった。

【００４７】（第３実施形態）次に第３の実施形態について図５で説明する。この実施形態については図５に示すように１つの中基板１２に対し３枚の上基板１３が接合される。また、第２の印加電極板２４には上基板１３ａ、１３ｂ、１３ｃの形状に対応し、且つコイルバネにより夫々独立して下方に押圧される３枚の印加電極板２４ａ、２４ｂ、２４ｃが取り付けられている。

【００４８】先ず下基板１１と中基板１２とをそれぞれ第１の印加電極板上に載置させ、次に上基板１３ａ、１３ｂ，１３ｃを支持保持部２３ａ、２３ｂ、２３ｃ上に載置させる。さらに第２の印加電極板２４を被せ、以下第２実施形態と同様に接合治具２０を３４０℃まで加熱昇温する。

【００４９】次に第２実施形態と同様に下基板１１と中基板１２とを直流電圧印加によって陽極接合し、その後駆動機構により押圧棒２６により第２の印加電極板２４を押圧することにより上基板１３ａ、１３ｂ、１３ｃを中基板１２上へ密着させる。この場合には個々の印加電極板２４ａ、２４ｂ、２４ｃがそれぞれ独立して取り付けられているので、上基板１３ａ、１３ｂ、１３ｃに基板厚み差があっても中基板１２への密着は可能である。

【００５０】中基板１２と上基板１３ａ、１３ｂ、１３ｃとに直流電圧を印加し、接合を完了する。

【００５１】このようにして接合された、中基板１２のダイヤフラム１０５を観察したところ、撓みや歪みの無い良好な状態であり、インクジェットヘッドとしての特性も同様に良好であった。

【００５２】各実施形態ではガラス製の下基板１１、シリコンの中基板１２を接合し、さらにガラス製の上基板１３を接合する場合を例にとって説明したが、上基板１３に半導体基板を用いてして、他の接合手段、例えばシリコン基板同士での直接接合を行う場合であっても良い。

【００５３】

【発明の効果】以上説明したように本発明によれば以下の効果を奏する。

【００５４】本発明の接合方法および接合装置によれば第３基板を第２基板上に非接触状態にて支持保持し、加熱昇温して第１基板と第２基板との第１の陽極接合した後に、第３基板を第２基板上に密着させて第２基板と第３基板間の陽極接合を行うため、第２基板に加わる応力を最小とすることができ、陽極接合後においても第２基板に内部応力の残存することのない接合体を形成することができる。

【００５５】特に第２の基板が他の基板に比べ薄く、また局所的にダイヤフラム等の薄肉部を有する場合、薄肉の存在によって半導体基板に撓みや歪みが発生し易く、またその薄肉部の撓みや歪みによって製造される素子特性が悪影響を被り易いので、本発明は特に効果的である。

【００５６】本実施形態では下基板１１、中基板１２を接合し、さらに上基板１３を接合する場合を例にとって説明したが、上基板１３の代わりに半導体基板として、他の接合手段、例えばシリコン基板同士での直接接合を行う場合であっても良い。

【図面の簡単な説明】

【図１】本発明に係わる第１実施形態を示す上面図のＡＡ´断面での概略縦断面図（ａ）及び概略上面図（ｂ）。

【図２】本発明に係わる第１実施形態における第２の陽極接合前の状態を示す概略縦断面図。

【図３】本発明に係わる第２実施形態における上面図のＡＡ´断面での概略断面図（ａ）及び概略上面図（ｂ）。

【図４】本発明に係わる第２実施形態における第２の陽極接合前の状態を示す概略縦断面図。

【図５】本発明に係わる第３実施形態における上面図ＡＡ´断面での概略断面図（Ａ）及び概略上面図（ｂ）。

【図６】本発明に係わる第３実施形態における第２の陽極接合前の状態を示す概略縦断面図。

【図７】インクジェットヘッドの製造工程の中の陽極接合による基板接合の状態を示す概略説明図。

【図８】本発明が適用されるインクジェットヘッドの一例を示す斜視図。

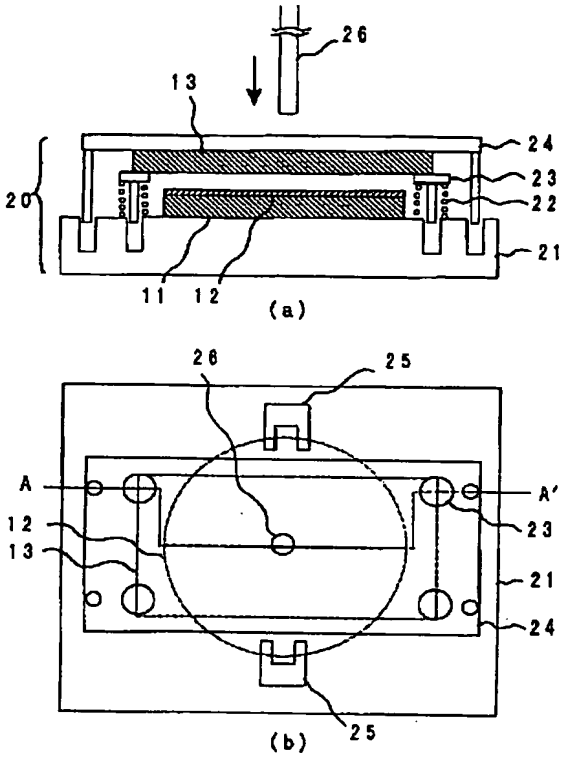
【図９】図８に示すインクジェットヘッドの断面図。

【符号の説明】

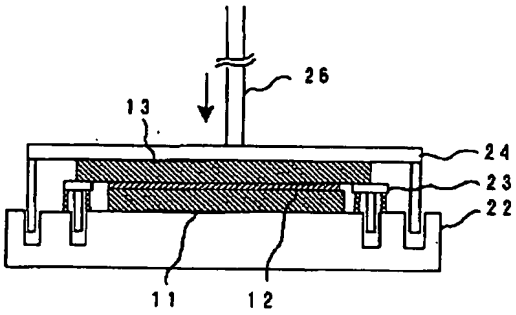
１１　下基板
１２　中基板
１３　上基板２０　接合装置（治具）
２１　第１の印加電極板
２２　コイルバネ
２３　支持保持部

２４　第２の印加電極板
２５　第３の印加電極
２６　押圧ピン

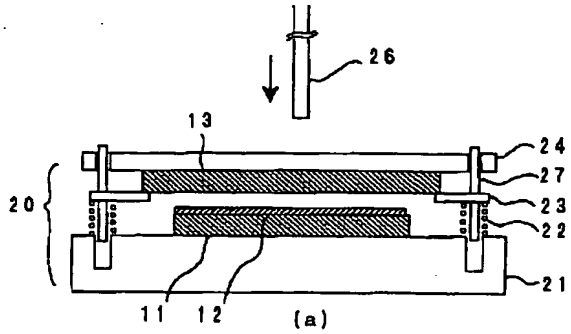
【図１】

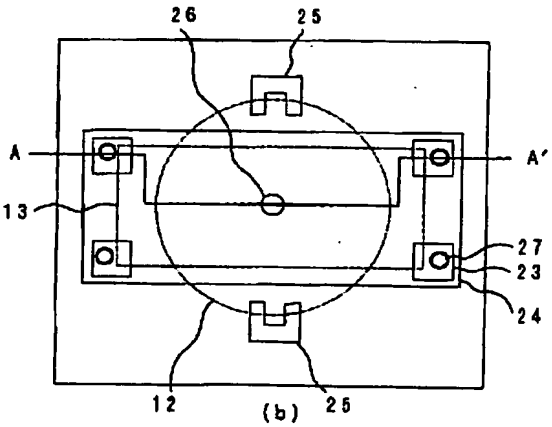


【図２】

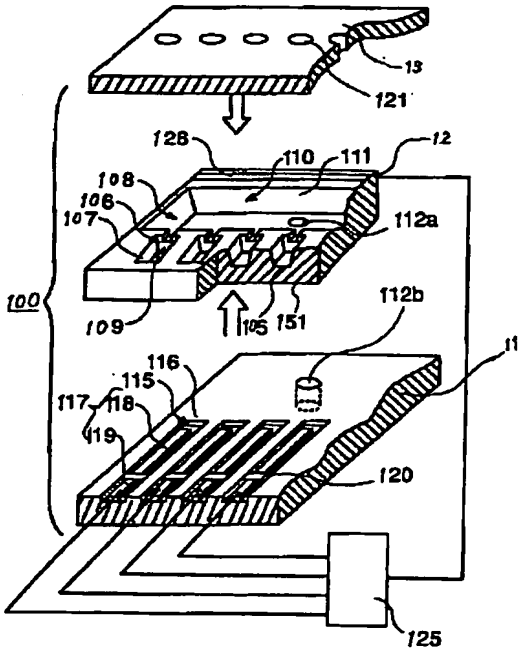


【図３】

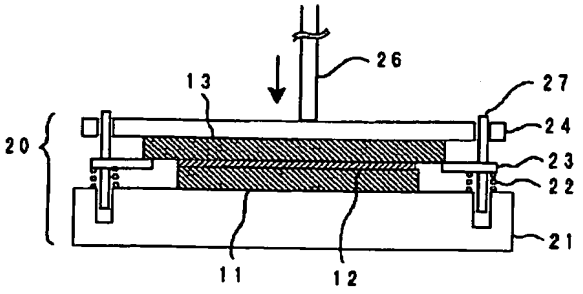




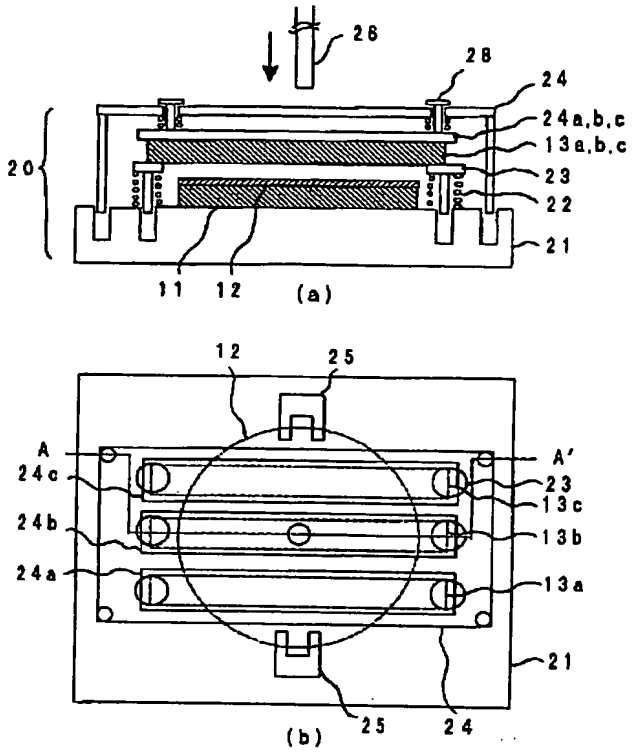
【図８】



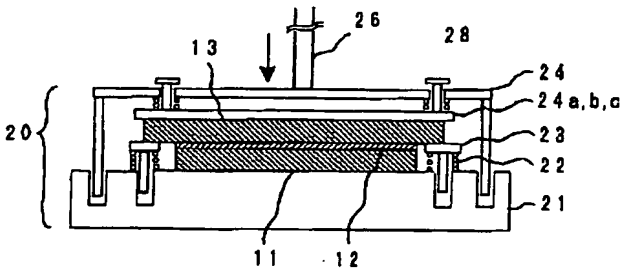
【図４】


26
13
27
24
20
23
22
21
11
12

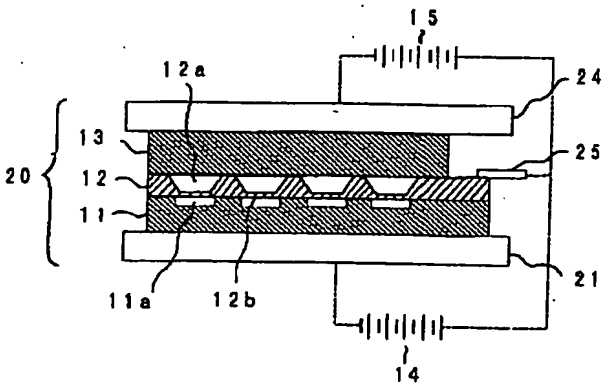
【図５】


26
28
24
24a,b,c
13a,b,c
20
23
22
21
11
12
(a)
12
25
A
A'
24c
23
13c
24b
13b
24a
13a
21
25
24
(b)

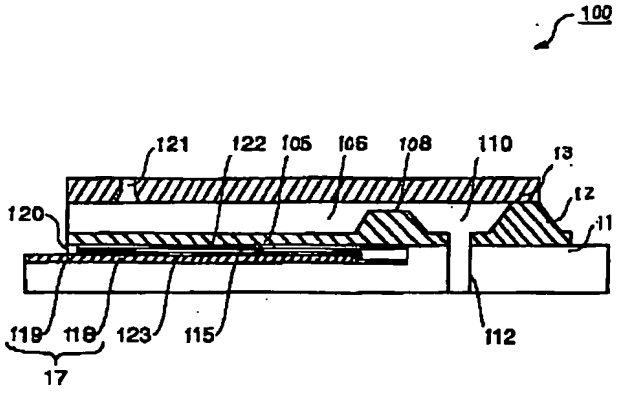
【図６】


26
28
13
24
24a,b,c
20
23
22
21
11
12

【図７】


15
12a
24
13
25
20
12
11
21
11a
12b
14

【図９】



フロントページの続き

(72)発明者　百瀬　芳正
長野県諏訪市大和３丁目３番５号　セイコーエプソン株式会社内

(72)発明者　八木　浩
長野県諏訪市大和３丁目３番５号　セイコーエプソン株式会社内

(72)発明者　田中　秀典
長野県諏訪市大和３丁目３番５号　セイコーエプソン株式会社内